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(54) **Heat-adhesive composite fiber and nonwoven fabric made by using same.**

(57) A heat-adhesive synthetic composite fiber useful as a bonding fiber for producing a nonwoven fabric by a wet sheet-forming method, comprises (A) an ethylene-vinyl alcohol copolymer filamentary constituent and (B) a metal sulfonate group-containing copolyester filamentary constituent incorporated to the ethylene-vinyl alcohol copolymer filamentary constituent (A) to form a composite fiber; the ethylene-vinyl alcohol copolymer filamentary constituent being exposed to the outside in at least a portion of the peripheral surface of the composite fiber.

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HEAT-ADHESIVE COMPOSITE FIBER AND NONWOVEN FABRIC MADE BY USING SAME

BACKGROUND OF THE INVENTION

1) Field of the Invention

5 The present invention relates to a heat-adhesive composite fiber and a nonwoven fabric made by using same. More particularly, the present invention relates to a heat-adhesive composite fiber comprising an ethylene-vinyl alcohol copolymer (referred to as "EVOH" hereinafter) filamentary constituent, and a specific modified copolyester filamentary constituent having a high bonding property to the EVOH filamentary constituent and useful as a binder fiber for producing nonwoven fabrics, and a nonwoven fabric made by
10 using same.

2) Description of the Related Art

In conventional synthetic fiber sheets, the individual synthetic fibers are bonded to each other through
15 polyvinyl alcohol binder fibers which are highly soluble in water. The polyvinyl alcohol fibers are advantageous in having a high hydrophilic property, dispersing property and bonding property under a wet-heating condition, but these polyvinyl alcohol binder fibers have a poor water-resistance. And thus the resultant synthetic fiber sheet in which the individual synthetic fibers are bonded to each other through the polyvinyl alcohol fibers exhibits a very poor mechanical strength when wet with water.

20 Also, when the synthetic fiber sheet containing the bonding polyvinyl alcohol fibers is heated in the presence of water, the bonding polyvinyl alcohol fibers are swollen or partially dissolved, and thus are deformed into film-like bonding layers which bond the individual synthetic fibers at relatively large bonding areas and block the gaps formed among the individual synthetic fibers. Accordingly, the resultant sheet exhibits a paper-like stiff touch and a poor permeability.

25 Recently, various throwaway materials, for example, throwaway wiping materials, diapers, sanitary materials and medical gloves, have been widely developed and are very popular. When disposed of by throwing into a water flush toilet, these throwaway materials must be easily divided and dispersed in water and flow away without blocking the discharge pipe. Nevertheless, when wet-heated, the polyvinyl alcohol film-like layers formed on the individual fibers exhibit a reduced solubility in cold water, and thus it is
30 difficult to divide and disperse the sheet in cold water.

To eliminate this disadvantage of the bonding polyvinyl alcohol fibers, Japanese Unexamined Patent Publication Nos. 2-68396 and 2-68397 disclose a process for producing polyvinyl alcohol fibers from a specific polyvinyl alcohol resin having a degree of saponification in a restricted range, under specific fiber-forming conditions. The resultant polyvinyl alcohol fibers, however, are not required to be dissolved in water
35 during the wet sheet-forming process (paper-forming process) at a temperature of 60 °C to 90 °C, and the polyvinyl alcohol fibers in the resultant sheet must be easily dispersed in water at a temperature of 10 °C to 40 °C. Accordingly, it is practically very difficult to realize the specific bonding polyvinyl alcohol fibers satisfying both of the above requirements, which are contradictory to each other.

An attempt has been made to form a nonwoven fabric by using, as bonding fibers, thermoplastic fibers
40 having a dry heat-fusibility, for example, composite fibers comprising a polyethylene resin constituent and a polypropylene resin constituent. These thermoplastic bonding fibers have a high hydrophobic property and a poor entangling property with other fibers. Therefore, when used in a high content to provide a synthetic fiber sheet by a wet sheet-forming method, the bonding fibers exhibit a poor processing property, and it is difficult to smoothly move same from a sheet-forming net to a wet felt and a dry felt. Accordingly, the
45 productivity of the synthetic fiber sheet is poor.

To eliminate the above-mentioned disadvantages, Japanese Examined Patent Publication (Kokoku) No. 54-44,773 discloses synthetic composite fibers comprising a sheath filamentary constituent comprising an ethylene copolymer, for example, EVOH and a core filamentary constituent comprising a polypropylene having a different melting point from that of the ethylene copolymer, and usable as bonding fibers for the
50 synthetic fiber sheet. These composite fibers are, however, disadvantageous in that, when heated at a temperature of more than 100 °C, the polypropylene core constituents in the composite fibers are heat-deformed, and thus it is difficult to produce a synthetic fiber sheet having a satisfactory bulkiness by using the above-mentioned bonding composite fibers.

Japanese Unexamined Patent Publication (Kokai) Nos. 56-26008 and 58-4820 disclose bonding composite fibers comprising a sheath constituent consisting of an EVOH and a core constituent composed of a

polyester fibers which have a high dimensional and shape stability, and a utilization of the bonding composite fibers for a nonwoven fabric to be made by a wet sheet-forming method. These bonding composite fibers, however, are disadvantageous in that the adhesive property of the EVOH constituent to the polyester constituent is poor, and therefore, even if the EVOH constituent and the polyester constituent
 5 are arranged in a core-in-sheath structure, the individual synthetic fibers cannot be firmly fixed at the intersecting points thereof through the composite fibers, and thus the resultant synthetic fiber sheet has an unsatisfactory mechanical strength.

Also, Japanese Examined Patent Publication (Kokoku) Nos. 56-17442 and 56-17444 disclose a process for producing a fiber consisting of an EVOH alone, but the fiber-forming property of the EVOH is not
 10 satisfactory, and thus the productivity of the EVOH fiber is low. Also, the resultant EVOH fiber is easily heat-deformable, and thus it is impossible to produce a nonwoven fabric having a high bulkiness and dimensional stability by using the EVOH fibers.

When synthetic fibers having a low melting point are used as binding fibers for producing a synthetic fiber sheet at a high temperature, the bonding fibers are melted in the sheet-forming process and adhered
 15 to a drying drum or a drying belt. Unfortunately, the resultant sheet becomes very soft during the sheet-forming process, and thus it is difficult to smoothly wind up such a sheet.

SUMMARY OF THE INVENTION

20 An object of the present invention is to provide a heat-adhesive synthetic composite fiber in which two different filamentary constituents are firmly bonded to each other and which is useful as a bonding fiber for producing a synthetic fiber sheet having a high dimensional stability, and a nonwoven fabric made by using same.

Another object of the present invention is to provide a heat-adhesive synthetic composite fiber which
 25 can be produced at a high spinning efficiency and is useful as a bonding fiber for producing nonwoven fabrics, and a nonwoven fabric produced by using same.

The above-mentioned objects can be attained by the heat-adhesive composite fiber of the present invention which comprises (A) an ethylene-vinyl alcohol copolymer filamentary constituent comprising a saponification product of a copolymer of (a) 30 to 70 molar% of ethylene with (b) 70 to 30 molar% of vinyl
 30 acetate, at a degree of saponification of at least 98%, and extending along the longitudinal axis of the fiber; and (B) a copolyester filamentary constituent comprising a copolyesterification product of (C) a dicarboxylic acid component comprising (i) 1.0 to 10.0 molar% of at least one organic dicarboxylic acid having at least one metal sulfonate group and (ii) the balance consisting of at least one aromatic dicarboxylic acid, with (d) a diol component comprising at least one diol compound, extending along the longitudinal axis of the
 35 composite fiber, and incorporated to the ethylene-vinyl alcohol copolymer filamentary constituent, the ethylene-vinyl alcohol copolymer filamentary constituent forming at least a portion of the peripheral surface of the composite fiber.

Also, the nonwoven fabric of the present invention is produced by a wet sheet-forming method from an aqueous slurry containing the heat-adhesive composite fibers as mentioned above and at least one other
 40 type of fibers.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The heat-adhesive synthetic composite fiber of the present invention comprises (A) an ethylene-vinyl
 45 alcohol copolymer filamentary constituent and (B) a metal sulfonate group-containing copolyester filamentary constituent incorporated to the filamentary constituent (A).

The ethylene-vinyl alcohol copolymer is a saponification product of a copolymer of (a) 30 to 70 molar% of ethylene with (b) 70 to 30 molar% of vinyl acetate, at a degree of saponification of at least 98%.

If the amount of ethylene (a) is less than 30 molar%, the resultant copolymer EVOH exhibits an
 50 unsatisfactory fiber-forming (spinning) property, an excessively high melting point of 180°C or more and an undesirably high wet heat bonding temperature, and therefore, it is difficult to firmly bond the resultant composite fiber and the other fibers to each other therethrough, by a dryer arranged in the wet sheet-forming process.

If the amount of ethylene is more than 70 molar%, the resultant copolymer EVOH exhibits a too high
 55 hydrophobic property, and thus a poor wet heat bonding property for the other fibers when wet heated and swollen with water, and therefore, the resultant nonwoven fabric exhibits a poor mechanical strength. Also, the resultant copolymer EVOH has a too low melting point of 120°C or less, and thus the resultant composite fibers are undesirably adhered to a dryer surface during the wet sheet-forming process and the

surface of the resultant nonwoven fabric is frequently stained by the adhered copolymer on the dryer surface. Furthermore, it is difficult to smoothly move the resultant composite fibers from a sheet-forming net to a felt surface in the wet sheet-forming process.

The ethylene-vinyl alcohol copolymer is a saponification product of the ethylene-vinyl acetate copolymer at a degree of saponification of at least 98%. If the saponification degree is less than 98%, the resultant copolymer is heat-decomposed and foamed in the melt-spinning process due to a poor thermal stability of the remaining vinyl acetate moiety, and thus cannot be smoothly melt spun.

The metal sulfonate group-containing copolyester filamentary constituent (B) comprises a copolyesterification product of (C) a dicarboxylic acid component comprising (i) 1.0 to 10.0 molar% of at least one organic dicarboxylic acid compound having at least one metal sulfonate group and (ii) the balance consisting of at least one aromatic dicarboxylic acid compound, with (d) a diol component comprising at least one diol compound.

The metal sulfonate group-containing dicarboxylic acid usable for the present invention is preferably selected from aromatic dicarboxylic acid compounds having one or two metal sulfonate groups, for example, isophthalic acid compounds having one or two metal sulfonate groups, such as 5-sodium sulfo-isophthalic acid or 5-potassium sulfo-isophthalic acid, and naphthalene dicarboxylic acid compounds having one or two metal sulfonate groups, such as 1,4-disodium sulfonaphthalene-2,6-dicarboxylic acid or 1-lithium sulfo-naphthalene-2,6-dicarboxylic acid.

In the modified copolyester, the content of the metal sulfonate group-containing dicarboxylic acid compound (i) is in the range of from 1.0 to 10.0 molar% based on the total molar amount of the dicarboxylic acid component (C). If the content of the metal sulfonate group-containing dicarboxylic acid compound (i) is less than 1.0 molar%, the resultant modified copolyester exhibits an unsatisfactorily low bonding property to the EVOH copolymer. Also, if the content of the metal sulfonate group-containing dicarboxylic acid compound (i) is more than 10.0 molar%, the resultant modified copolyester exhibits an unsatisfactory fiber-forming (spinning) property.

Preferably, the metal sulfonate group-containing dicarboxylic acid component is contained in a content of from 2.0 to 5.0 molar% in the dicarboxylic acid component (C).

The metal for the metal sulfonate group is preferably selected from alkali metals, for example, sodium, potassium and lithium, and alkali earth metals.

The aromatic dicarboxylic acid compound (ii) to be copolymerized with the metal sulfonate group-containing dicarboxylic acid compound (i) is preferably terephthalic acid.

The aromatic dicarboxylic acid compound (ii) may contain a small amount of at least one aromatic dicarboxylic acid other than terephthalic acid, for example, 25 molar% or less of isophthalic acid or 2,6-naphthalene dicarboxylic acid.

The diol compound for the diol component is preferably selected from the group consisting of ethylene glycol and butylene glycol.

The metal sulfonate group-containing copolyester may be blended with a small amount, for example, 30% by weight or less, of another polyester, for example, a non-modified polyester such as polyethylene terephthalate or polybutylene terephthalate, or a polyolefin.

The ethylene-vinyl alcohol copolymer filamentary constituent and the metal sulfonate group-containing copolyester filamentary constituent extend in parallel to each other and along the longitudinal axis of the composite fiber, and are incorporated with each other to form the composite fiber.

The specific metal sulfonate group-containing copolyester filamentary constituent as defined above has a high bonding property to the specific ethylene-vinyl alcohol copolymer filamentary constituent, and thus they are firmly bonded to each other.

In the composite fiber of the present invention, the ethylene-vinyl alcohol copolymer filamentary constituent must form at least a portion of the peripheral surface of the composite fiber.

In other words, at least a portion of the ethylene-vinyl alcohol copolymer filamentary constituent is exposed to the outside in at least a portion of the peripheral surface of the composite fiber, and thus the composite fiber can be heat-adhered to other fibers through the exposed portion of the ethylene-vinyl alcohol copolymer filamentary constituent.

In an embodiment of the composite fiber of the present invention, the ethylene-vinyl alcohol copolymer filamentary constituent and the metal sulfonate group-containing copolyester filamentary constituent are incorporated with each other in a side-by-side arrangement or in a bi-metal form.

In another embodiment of the composite fiber of the present invention, a core composed of the metal sulfonate group-containing copolyester filamentary constituent is surrounded by a sheath composed of the ethylene-vinyl alcohol copolymer filamentary constituent in a core-in-sheath arrangement.

In this core-in-sheath composite fiber, the core constituent is concentrically or eccentrically located in

the sheath constituent. Usually, the eccentric core-in-sheath type composite fiber is preferable, because the properties of the core constituent and the sheath constituent can be synergistically utilized for the composite fiber and the other fibers in the nonwoven fabric.

In the composite fiber of the present invention, the ethylene-vinyl alcohol copolymer filamentary constituent is preferably in an amount of 10% to 80% based on the total weight of the composite fiber.

In a use in which the specific properties, for example, a high hydrophilic property and heat-adhesive property, of the ethylene-vinyl alcohol copolymer filamentary constituent is mostly utilized, the content of the ethylene-vinyl alcohol copolymer filamentary constituent should be increased. In another use in which the hydrophobic property of the metal sulfonate group-containing copolyester filamentary constituent and the surface property (heat adhesive property) of the ethylene-vinyl alcohol copolymer filamentary constituent are specifically utilized, both filamentary constituents are preferably incorporated in the core-in-sheath arrangement, and the content of the ethylene-vinyl alcohol copolymer filamentary constituent is reduced.

In still another embodiment of the composite fiber of the present invention, one or more ethylene-vinyl alcohol copolymer filamentary constituents and one or more metal sulfonate group-containing copolyester filamentary constituents are alternately superimposed in a multi-layer arrangement.

In still another embodiment, two or more cores each composed of a metal sulfonate group-containing copolyester filamentary constituent and independent from one another are embedded in a matrix composed of the ethylene-vinyl alcohol copolymer filamentary constituent in an islands-in-a-sea arrangement, or a multi-core-in-sheath arrangement.

At least one of the filamentary constituents optionally contains at least one additive selected from, for example, pigments, delustering agents, stainproof agents, and dyes.

The composite fiber of the present invention can be produced by a composite fiber-melt spinning process and apparatus.

In an example of the process, an EVOH copolymer is melted in an extruder at a temperature of 170 °C to 220 °C and separately, a modified copolyester is melted in a separate extruder at a temperature of 270 °C to 300 °C. Then the EVOH copolymer melt and the modified copolyester melt are introduced into and extruded through a composite fiber-spinning nozzle at a temperature of 280 °C to 300 °C, and the resultant undrawn composite filaments are drawn under known polyester filament-drawing conditions. For example, when producing a multifilament yarn, the undrawn composite filaments are drawn on a heating roller or pin at a temperature of 60 °C to 80 °C at a draw ratio of 3 to 5. Also, when producing short fibers, the undrawn composite filaments are drawn in hot water at a temperature of 70 °C to 80 °C, at a draw ratio of 2.5 to 4.5. If necessary, the drawn filaments are heat set at a temperature of 80 °C to 140 °C under a tension or while being relaxed. Also, the drawn filaments are optionally subjected to a crimping procedure.

Surprisingly, in the resultant composite fiber, the EVOH copolymer filamentary constituent is firmly bonded to the metal sulfonate group-containing copolyester filamentary constituent at a very high bonding strength. The mechanism of the firm bonding has not been clarified at the present stage, but it is assumed that strong hydrogen bonds are generated between the hydroxyl groups in the EVOH copolymer molecule and the metal sulfonate groups in the copolyester molecule in the presence of a small amount of water and cause the firm bonding of the EVOH copolymer filamentary constituent to the modified copolyester filamentary constituent.

The heat-adhesive composite fibers of the present invention can be utilized as continuous multifilaments. Usually, the composite fibers of the present invention are converted to a nonwoven fabric consisting of the composite fibers by a wet sheet (paper)-forming method. Alternatively, the composite fibers are mixed, as bonding fibers, with non-adhesive fibers, for example, natural fibers such as cotton or hemp fibers, or synthetic fibers such as polyester, polyamide or polyolefin fibers, and the mixed fibers are converted to a nonwoven fabric. In these nonwoven fibers, the non-adhesive fibers are entangled with each other and firmly bonded at the points of contact thereof to each other, through the EVOH copolymer constituents of the bonding fibers, and therefore, the resultant nonwoven fabric has a high mechanical strength.

Since the EVOH copolymer filamentary constituent is supported by the modified copolyester filamentary constituent having a high stability in the wet condition, the composite fiber of the present invention exhibits and maintains a high mechanical strength even in a wet condition.

When the cellulose fibers, for example, wood pulp, linter pulp, hemp and rayon fibers with a poor water-resistance, are contained in the nonwoven fabric, the composite fibers of the present invention effectively enhance the water resistance and wet dimensional stability of the nonwoven fabric.

The resultant nonwoven fabric has a heat-sealing property, and thus is useful for producing tea bags, cake-refining sheets, paper wrapping sheets for confectionery, and bulky tissue paper sheets.

Further, the nonwoven fabric has a satisfactory bonding property to water-insoluble polyvinyl alcohol

fibers or polyester fibers, and thus can be used as a support for an adhesive tape.

The composite fibers of the present invention in the form of a continuous filament yarn can be used for producing a larva cultivating net. Also, the composite filament yarn of the present invention has a high bonding processability, and thus can be used to produce a rubber-coated fabric sheet.

5 When the composite fibers of the present invention are used as bonding fibers for non-adhesive fibers, to produce a nonwoven fiber blend fabric, the content of the composite fibers in the fiber blend is preferably at least 5% by weight. If the content of the composite fibers is less than 5% by weight, the resultant nonwoven fabric has an unsatisfactory mechanical strength.

The non-adhesive fibers to be blended with the composite fibers of the present invention may comprise
10 at least one member selected from the group consisting of inorganic fibers, for example, glass fibers; natural fibers, for example, wood pulp, linter pulp, cotton and hemp fibers; regenerated fibers, for example, rayon fibers; semi-synthetic fibers, for example, cellulose acetate fibers; and synthetic fibers, for example, polyolefin, polyester, polyamide, polyacrylic, aramid and water-insoluble polyvinyl alcohol fibers. Preferably, the non-adhesive fibers are cellulose fibers, water-insoluble polyvinyl alcohol fibers, polyamide fibers and
15 aramid fibers, which have a high affinity to the EVOH copolymer.

The nonwoven fabric containing the bonding composite fibers of the present invention is advantageous in that, since the EVOH copolymer filamentary constituent is firmly bonded to the modified copolyester filamentary constituent, the bonding composite fibers are not adhered to the wire, felt and drying drum during the wet sheet-forming process, in comparison with conventional bonding fibers consisting of
20 polyvinyl alcohol, and thus the wet sheet-forming process can be smoothly and stably carried out.

The heat-adhesive composite fibers of the present invention can be used for a dimensionally stable nonwoven fabric, heat-resistant nonwoven fabric, flushable nonwoven fabric which is easily divided and dispersed in water, for example, in a water flush toilet, or a heat-sealing nonwoven fabric.

For example, the nonwoven fabric containing the heat-adhesive composite fibers of the present
25 invention can be used as a tea bag, cake-refining sheet, confectionery wrapping sheet, cleaning wiper sheet or an antiseptic solution-containing wiper sheet. Also, a nonwoven fabric in which inorganic fibers, for example, glass fibers, are bonded to each other through the heat-adhesive composite fibers of the present invention has a high water resistance, and a high dimensional and shape stability, and thus is usable for roofing, cushion flooring and air filters.

30 In a conventional heat-sealing nonwoven fabric for tea bags, in which non-adhesive fibers are bonded to each other through heat-adhesive polyolefin fibers, if the heat sealing temperature is raised to increase the tea bag-producing speed, the bonding polyolefin fibers are easily broken and adhered to a heating roll surface, and thus the tea bag-producing efficiency is lowered. When the heat-sealing nonwoven fabric of the present invention is used, the tea bags can be produced at a high speed, without the above-mentioned
35 disadvantages.

EXAMPLES

The present invention will be further explained by the following examples.

40 In the examples, the intrinsic viscosity number $[\eta]_{inh}$ of a polyester was determined at a concentration of 0.5 g/100 ml in a medium consisting of o-chlorophenol at a temperature of 30 °C.

The melt flow ratio (MFR) of an EVOH copolymer was determined in accordance with Japanese Industrial Standard (JIS) K7210.

The tensile strength of a fiber was measured in accordance with JIS P8113.

45 The air permeability of a nonwoven fabric was measured in accordance with JIS P8117.

The divide-dispersing property of a nonwoven fabric in water was measured and evaluated in the following manner.

An Erlenmeyer flask having a capacity of 200 ml was charged with 100 ml of water, and a cylindrical rotator having a diameter of 7 mm and a length of 30 mm was placed in the flask.

50 The flask was placed on a magnetic stirrer and the cylindrical rotator was rotated at a controlled rotation number of 500 rpm \pm 20 rpm.

A nonwoven fabric specimen in the form of a 7 cm x 7 cm square was placed in the flask and stirred, to allow the specimen to be completely divided and dispersed in water until the original form thereof is lost.

The stirring time necessary for a complete loss of the original form of the nonwoven fabric specimen
55 was measured.

The divide-dispersing property of the specimen was indicated in the following classes.

Class	Stirring time
4	10 seconds or less
3	30 seconds or less but more than 10 seconds
2	60 seconds or less but more than 30 seconds
1	More than 60 seconds

Example 1

A modified polyethylene terephthalate resin containing copolyesterified 5-sodium-sulfoisophthalic acid in an amount of 3.5 molar% based on the total molar amount of the dicarboxylic acid component, and having an intrinsic viscosity number $[\eta]_{inh}$ of 0.53 was used for forming a core filamentary constituent.

An EVOH copolymer containing copolymerized ethylene in an amount of 45 molar% and having a degree of saponification of copolymerized vinyl acetate of 99.8 molar% and an MFR of 5.5 was used for forming a sheath filamentary constituent.

The modified copolyester was melted in an extruder at a temperature of 295 °C, and separately, the EVOH copolymer was melted in another extruder at a temperature of 215 °C. The modified copolyester melt and the EVOH copolymer melt were then introduced into and extruded through a core-in-sheath type composite fiber-spinning nozzle head at a spinning rate of 980 m/min.

The ratio in weight of the core constituent to the sheath constituent was 60:40, and the resultant undrawn filament yarn had a yarn count of 7000 denier 760 filaments.

A yarn bundle was prepared by bundling 24 undrawn filament yarns, which bundle was then drawn in a hot water bath at a temperature of 78 °C and at a draw ratio of 3.4.

Then, the drawn yarn bundle was heat-treated in a hot water bath at a temperature of 88 °C, to relax the yarn bundle at a shrinkage of 10%. The resultant drawn, relaxed individual filaments had a denier of 3.0, a tensile strength of 4.7 g/d, and an ultimate elongation of 39%. No fuse-adhesion of the individual filaments in the yarn bundle was found in the spinning and drawing steps.

The yarn bundle was cut to a length of 5 mm, and the resultant short composite fibers were dispersed in an amount of 30% by weight in water together with 70% by weight of wood pulp, which was beaten to a Canadian Standard Freeness of 460 ml. The resultant aqueous slurry was converted to a nonwoven fabric having a desired dry basis weight of 30 g/m², at a sheet-forming speed of 5 m/min by a test cylinder paper machine, and the resultant wet nonwoven fabric was dried at a temperature of 125 °C by a drum dryer.

The resultant pulp-blended nonwoven fabric had a dry basis weight of 33.4 g/m², a thickness of 0.092 mm, a density of 0.36 g/cm³, and a dry tensile strength of 2.4 kg/15 mm in the longitudinal (machine) direction and of 1.0 kg/15 mm in the transversal (cross) direction of the nonwoven fabric.

When tested immediately after the nonwoven fabric was immersed in water at room temperature for one hour, the nonwoven fabric had a wet tensile strength of 1.5 kg/15 mm in the longitudinal direction and of 0.7 kg/15 mm in the transversal direction and exhibited a high wet dimensional stability and water-resistance.

Comparative Example 1

The same procedures as in Example 1 were carried out with the following exceptions.

The core filamentary constituent consisted of a polyethylene terephthalate homopolymer having an intrinsic viscosity number $[\eta]_{inh}$ of 0.64. The drawn and heat treated individual filaments had a denier of 3.2, a tensile strength of 3.1 g/d, and an ultimate elongation of 46%.

The resultant nonwoven fabric had a basis weight of 32.5 g/m², a thickness of 0.102 mm, a density of 0.32 g/cm³, a relatively low dry tensile strength of 2.0 kg/15 mm in the longitudinal direction and of 0.8 kg/15 mm in the transversal direction, and a very poor wet tensile strength of 0.7 kg/15 mm in the longitudinal direction and of 0.25 kg/15 mm in the transversal direction.

Example 2

The same procedures as in Example 1 were carried out with the following exceptions.

The core filamentary constituent was made from a modified copolyethylene terephthalate resin containing copolyesterified 5-sodium-sulfo-isophthalic acid in an amount of 2.5 molar% based on the total molar

amount of the dicarboxylic acid component, and having an intrinsic viscosity number (η_{inh}) of 0.50.

The sheath filamentary constituent was made from an EVOH copolymer containing 38 molar% of copolymerized ethylene and having a degree of saponification of the copolymerized vinyl acetate of 99.8 molar% and an MFR of 2.5.

5 The drawn, heat treated individual filaments had a denier of 3.2, a tensile strength of 4.8 g/d, and an ultimate elongation of 41%.

The resultant nonwoven fabric had a basis weight of 31 g/m², a thickness of 0.084 mm, a density of 0.37 g/cm³, a dry tensile strength of 2.6 kg/15 mm in the longitudinal direction and of 1.1 kg/15 mm in the transversal direction and a wet tensile strength of 1.7 kg/15 mm in the longitudinal direction and of 0.8 kg/15 mm in the transversal direction, and exhibited a high wet dimensional stability.

Comparative Example 2

The same procedures as in Example 2 were carried out with the following exceptions.

15 The core filamentary constituent consisted of a polyethylene terephthalate homopolymer having an intrinsic viscosity number [η_{inh}] of 0.64. The drawn and heat treated individual filaments had a denier of 3.0, a tensile strength of 2.9 g/d and an ultimate elongation of 48%.

The resultant nonwoven fabric had a basis weight of 33.3 g/m², a thickness of 0.108 mm, a density of 0.31 g/cm³, a relatively low dry tensile strength of 1.9 kg/15 mm in the longitudinal direction and of 0.6 kg/15 mm in the transversal direction, and a very poor wet tensile strength of 0.6 kg/15 mm in the longitudinal direction and of 0.24 kg/15 mm in the transversal direction.

Example 3

25 The same procedures as in Example 1 were carried out with the following exceptions.

The core filamentary constituent was made from a modified copolyethylene terephthalate resin containing copolyesterified 1,5-disodium-sulfo-naphthalene-2,6-dicarboxylic acid in an amount of 2.0 molar% based on the total molar amount of the dicarboxylic acid component, and having an intrinsic viscosity number (η_{inh}) of 0.76.

30 The sheath filamentary constituent was made from an EVOH copolymer containing 50 molar% of copolymerized ethylene and having a degree of saponification of the copolymerized vinyl acetate of 99.8 molar% and an MFR of 12.

The drawn, heat treated individual filaments had a denier of 2.9, a tensile strength of 5.1 g/d, and an ultimate elongation of 46%.

35 The resultant nonwoven fabric had a basis weight of 32 g/m², a thickness of 0.087 mm, a density of 0.37 g/cm³, a dry tensile strength of 2.5 kg/15 mm in the longitudinal direction and of 1.0 kg/15 mm in the transversal direction and a wet tensile strength of 1.6 kg/15 mm in the longitudinal direction and of 0.7 kg/15 mm in the transversal direction, and exhibited a high wet dimensional stability and water resistance.

Comparative Example 3

The same procedures as in Example 3 were carried out with the following exceptions.

45 The core filamentary constituent consisted of a polybutylene terephthalate homopolymer having an intrinsic viscosity number [η_{inh}] of 0.87. The drawn and heat treated individual filaments had a denier of 3.1, a tensile strength of 3.2 g/d and an ultimate elongation of 47%.

The resultant nonwoven fabric had a basis weight of 33.1 g/m², a thickness of 0.102 mm, a density of 0.31 g/cm³, a relatively low dry tensile strength of 1.9 kg/15 mm in the longitudinal direction and of 0.8 kg/15 mm in the transversal direction, and a very poor wet tensile strength of 0.51 kg/15 mm in the longitudinal direction and of 0.25 kg/15 mm in the transversal direction.

Examples 4 to 7

In each of Examples 4 to 7, the same procedures as in Example 1 were carried out with the following exceptions.

55 In the EVOH copolymer, the molar content of the copolymerized ethylene was as indicated in Table 1, and the degree of saponification of the copolymerized vinyl acetate was 99.8 molar%.

In the resultant composite fibers, the weight ratio of the core filamentary constituent to the sheath filamentary constituent was 50:50, and the resultant individual composite filaments had a denier of 2.0.

The resultant short composite binder fibers having a length of 5 mm were suspended in an amount of 20% by weight, together with 80% by weight of soft wood kraft pulp (NBKP) beaten to a Canadian Standard Freeness of 460 ml, in water. The resultant aqueous slurry was subjected to the same sheet (paper)-forming process as in Example 1, except that the resultant wet nonwoven fabric was dried at a temperature of 115°C by using an Yankee dryer.

The resultant dried nonwoven fabric had a basis weight of 30 g.m² and the physical properties as indicated in Table 1.

Comparative Examples 4 and 5

In each of Comparative Examples 4 and 5, the same procedures as in Example 4 were carried out with the following exceptions.

In Comparative Example 4, the nonwoven fabric (paper sheet) was prepared from the NBKP alone.

In Comparative Example 5, the composite fibers were replaced by polyethylene terephthalate homopolymer short fibers having a denier of 2.0 and a length of 5 mm.

The physical properties of the resultant nonwoven fabrics of Comparative Examples 4 and 5 are shown in Table 1.

As Table 1 clearly indicates, the nonwoven fabrics of Examples 4 to 7 had a high tensile strength and bulkiness, when compared with those of Comparative Examples 4 and 5.

Table 1

Item	Bonding composite fiber			Content of PET (*)1 fiber in nonwoven fabric (wt%)	Content of NBKP in nonwoven fabric (wt%)	Nonwoven fabric			
	Content of ethylene in EVOH copolymer (molar%)	Amount of composite fiber in nonwoven fabric (wt%)	Basis weight (g/m ²)			Thick-ness (mm)	Tensile strength (*)2 (kg/15 mm)	Air permea-bility (Sec/100 ml)	
Example No.	4	33	20	-	80	30.1	0.110	1.45	3.8
	5	38	20	-	80	30.4	0.112	1.52	4.5
	6	44	20	-	80	30.2	0.113	1.48	3.4
	7	38	20	-	80	30.1	0.108	1.59	4.1
Compar-ative Example	4	-	-	-	100	29.8	0.103	1.41	8.6
	5	-	-	20	80	30.1	0.111	1.03	4.2

Note: (*)₁ ... PET: Polyethylene terephthalate(*)₂ ... Tensile strength in the longitudinal direction

Example 8

The same procedures as in Example 4 were carried out with the following exceptions.
 The core filamentary constituent was made from a modified copolyethylene terephthalate resin contain-

ing copolyesterified spotassium-sulfoisophthalic acid in an amount of 2.5 molar% based on the total molar amount of the dicarboxylic acid component, and having an intrinsic viscosity number (η_{inh}) of 0.48.

The sheath filamentary constituent was made from an EVOH copolymer containing 44 molar% of copolymerized ethylene and having a degree of saponification of the copolymerized vinyl acetate of 99.8 molar%.

The weight ratio of the core filamentary constituent to the sheath filamentary constituent was 30:70. and the drawn, heat treated individual short composite fibers had a denier of 1.5 and a length of 5 mm.

In the nonwoven fabric, the weight ratio of the composite fibers to the NBKP was 40:60.

The physical properties of the resultant nonwoven fabric are indicated in Table 2.

Comparative Example 6

The same procedures as in Example 8 were carried out, with the following exceptions.

The nonwoven fabric was prepared from 30% by weight of polyethylene terephthalate homopolymer fibers having a denier of 1.5 and a length of 5 mm, 10% by weight of polyvinyl alcohol binder fibers available under the trademark of VPB 105, from Kuraray K.K. and having a denier of 2 and a length of 3 mm, and 60% by weight of the same NBKP as in Example 8. This nonwoven fabric had a bulk density similar to that of Example 8.

The physical properties of the nonwoven fabric are shown in Table 2.

Table 2

Item	Example No. (% by weight)	Example 8	Comparative Example 6
Composition of non-woven fabric	Composite binder fiber NBKP	40% PET fiber 60% PVA binder fiber NBKP	30% 10% 60%
Nonwoven fabric			
Basis weight (g/m ²)		30.2	30.7
Thickness (mm)		0.159	0.161
Bulk density (g/cm ³)		0.190	0.191
Dry tensile strength (kg/15 mm) ^(*) ₂		1.36	1.84
Wet tensile strength (kg/15 mm) ^(*) ₃		0.24	The binder fibers were completely dissolved and the original form of the fabric was completely lost.

Note: ^(*)₂ ... In the longitudinal direction of the fabric

^(*)₃ ... The nonwoven fabric specimen was immersed in boiling water for 5 minutes, and the wet tensile strength of the specimen then measured.

Table 2 shows that the nonwoven fabric of the present invention has a high hot water resistance.

Example 9

The same procedures as in Example 4 were carried out with the following exceptions.

The core filamentary constituent was made from a modified copolyethylene terephthalate resin containing copolyesterified 5-sodium-sulfo-isophthalic acid in an amount of 4.5 molar% based on the total molar amount of the dicarboxylic acid component, and having an intrinsic viscosity number (η_{inh}) of 0.46.

5 The sheath filamentary constituent was made from an EVOH copolymer containing 33 molar% of copolymerized ethylene and having a degree of saponification of the copolymerized vinyl acetate of 99.9 molar%.

The weight ratio of the core constituent to the sheath constituent was 80:20, and the resultant individual composite binder fibers had a denier of 3.0 and a length of 5 mm.

10 The nonwoven fabric was made from 50% by weight of the composite binder fibers and 50% by weight of the NBKP.

The test results are shown in Table 3.

Comparative Example 7

15 The same procedures as in Example 9 were carried out, except that the nonwoven fabric having a bulk density similar to that in Example 9 was produced from 45% by weight of polyethylene terephthalate homopolymer short fibers having a denier of 3.0 and a length of 5 mm, 5% by weight of the same PVA binder fibers in Comparative Example 6, and 50% by weight of the same NBKP as in Example 4.

The test results are shown in Table 3.

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Table 3

Item	Example No.	Example 9	Comparative Example 7
Composition of non-woven fabric	(% by weight)	Composite binder fiber 50% NBKP	PET fiber 45% PVA binder fiber 5% NBKP 50%
Nonwoven fabric			
Basis weight	(g/m ²)	35.5	34.8
Thickness	(mm)	0.195	0.194
Bulk density	(g/cm ³)	0.182	0.179
Dry tensile strength ^(*)	2 (kg/15 mm)	1.15	1.43
Divide-dispersing property in water	(class)	4	2

Note: (*)₂ ... In the longitudinal direction of the fabric.

Table 3 shows that the non-woven fabric had a high water resistance.

Claims

1. A heat-adhesive synthetic composite fiber comprising:

- (A) an ethylene-vinyl alcohol copolymer filamentary constituent comprising a saponification product of a copolymer of (a) 30 to 70 molar% of ethylene with (b) 70 to 30 molar% of vinyl acetate, at a degree of saponification of at least 98%, and extending along the longitudinal axis of the composite fiber; and
- (B) a copolyester filamentary constituent comprising a copolyesterification product of (c) a dicarboxylic acid component comprising (i) 1.0 to 10.0 molar% of at least one organic dicarboxylic acid compound having at least one metal sulfonate group and (ii) the balance consisting of at least one aromatic dicarboxylic acid compound, with (d) a diol component comprising at least one diol compound, extending along the longitudinal axis of the composite fiber, and incorporated to the ethylene-vinyl alcohol copolymer filamentary constituent,
- said ethylene-vinyl alcohol copolymer filamentary constituent forming at least a portion of the peripheral surface of the composite fiber.
2. The composite fiber as claimed in claim 1, wherein the ethylene-vinyl alcohol copolymer filamentary constituent and the metal sulfonate group-modified copolyester filamentary constituent are incorporated in a side-by-side arrangement.
 3. The composite fiber as claimed in claim 1, wherein a core composed of the metal sulfonate group-containing copolyester filamentary constituent is surrounded by a sheath composed of the ethylene-vinyl alcohol copolymer filamentary constituent in a core-in-sheath arrangement.
 4. The composite fiber as claimed in claim 1, wherein the ethylene-vinyl alcohol copolymer filamentary constituent is in an amount of 10 to 80% based on the total weight of the composite fiber.
 5. The composite fiber as claimed in claim 1, wherein the ethylene-vinyl alcohol copolymer has a melting point of at least 120° C.
 6. The composite fiber as claimed in claim 1, wherein the aromatic dicarboxylic acid compound is terephthalic acid.
 7. The composite fiber as claimed in claim 1, wherein the diol compound is selected from the group consisting of ethylene glycol and butylene glycol.
 8. The composite fiber as claimed in claim 1, wherein the metal sulfonate group-comprising organic dicarboxylic acid is selected from the group consisting of metal sulfonate group-containing isophthalic acids, 1,4-metal sulfonaphthalene 2,6-dicarboxylic acid and 1-metal sulfonaphthalene-2,6-dicarboxylic acid.
 9. A nonwoven fabric produced by a wet sheet-forming method from an aqueous slurry containing the heat-adhesive composite fibers as defined in claim 1 and at least one other type of fibers.
 10. The nonwoven fabric as claimed in claim 9, wherein the heat adhesive composite fibers are in an amount of at least 5% based on the total weight of the nonwoven fabric.
 11. The nonwoven fabric as claimed in claim 9, wherein the other type of fibers is selected from the group consisting of inorganic fibers, cellulosic fibers, polyolefin fibers, polyester fibers, polyamide fibers, polyacrylic fibers and aramid fibers.

DERWENT-ACC-NO: 1991-179409

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TITLE: Heat-adhesive composite fibre for bonding nonwoven fabrics comprises a saponified ethylene!-vinyl! alcohol copolymer and a metal sulphonate-modified polyester

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ABSTRACTED-PUB-NO: EP 432489 A**BASIC-ABSTRACT:**

A heat-adhesive synthetic composite fibre for use as a bonding agent in nonwoven fabrics comprises: (A) an ethylene-vinyl alcohol copolymer filament comprising a saponification prod. of a copolymer of (a) 30-70 mol.% ethylene with (b) 70-30 mol.% vinyl acetate, saponified to at least 98%, and extending along the longitudinal axis of the composite fibre, and (B) a copolyester filament comprising (c) a dicarboxylic acid comprising (i) 1.0-10.0 mol.% of a dicarboxylic acid contg. a metal sulphonate gp. and (ii) the balance comprising an aromatic dicarboxylic acid, reacted with (d) a diol. The copolyester extends along the longitudinal axis of the composite, and incorporates (A). (A) forms a part of the peripheral surface of the composite.

Components (A) and (B) are incorporated either side by side or as a core of (B) surrounded by a sheath of (A). (A) contributes 10-80% of the total wt. and has a m.pt. of at least 120 deg.C.

Terephthalic acid is the aromatic dicarboxylic acid. The diol is ethylene or butylene glycol. The metal sulphonate modified acid is selected from isophthalic acid derivs., 1,4-metal sulphonaphthalene-2,6-dicarboxylic acid and 1-metal sulphonaphthalene-2,6-dicarboxylic acid. Nonwoven fabrics contain at least 5% of the total wt. of the composite with an inorganic, cellulosic, polyolefin, polyester, polyamide, polyacrylic, or aramid fibre.

USE/ADVANTAGE - For producing nonwoven fibre by a wet sheet-forming method, and synthetic fibre sheets with high dimensional stability. @(15pp Dwg. No.0/0)

TITLE-TERMS: HEAT ADHESIVE COMPOSITE FIBRE BOND
 NONWOVEN FABRIC COMPRISE
 SAPONIFICATION POLYETHYLENE
 POLYVINYL ALCOHOL COPOLYMER METAL
 SULPHONATE MODIFIED POLYESTER

DERWENT-CLASS: A14 A17 A94 F01

CPI-CODES: A05-E01B; A10-E09A; A12-A05; A12-S05B;
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Key Serials:

0004	0016	0037	0044	0047	0203
0226	0231	0232	0241	0367	0368
0789	1283	1291	1315	1317	1319
1323	1331	1337	1454	1456	1462
1464	1475	1477	1974	2007	2008
2413	2414	2458	2475	2476	2486
2510	2525	2528	2559	2562	2601
2604	2635	2646	2654	2667	2684
2801	2820	3155	3226	3251	3254
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141	143	144	151	155	157	162	163
166	167	168	169	170	171	173	174
175	230	231	244	245	252	27&	30&
32&	33&	331	36&	398	415	428	429
437	447	455	481	483	50&	512	514
53&	532	533	535	540	541	542	546
547	551	56&	567	57&	573	575	58&
581	596	597	600	604	608	609	657
664	665	688	722	724	725	726	

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